PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : G01B 11/06 | A1

(11) International Publication Number: WO 98/29709

(43) International Publication Date: 9 July 1998 (09.07.98)

(21) International Application Number: PCT/SE97/02043

(22) International Filing Date: 8 December 1997 (08.12.97)

(30) Priority Data:
9604638-8 17 December 1996 (17.12.96) SE

(71) Applicant *(for all designated States except US)*: TOOLEX ALPHA AB [SE/SE]; P.O. Box 1176, S-172 24 Sundbyberg (SE).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: ÖHMAN, Ove [SE/SE]; Asplunda, Uppsala-Näs, S-755 91 Uppsala (SE).

(74) Agents: WINBLAD, Peter et al.; H. Albihns Patentbyrå AB, P.O. Box 3137, S-103 62 Stockholm (SE).

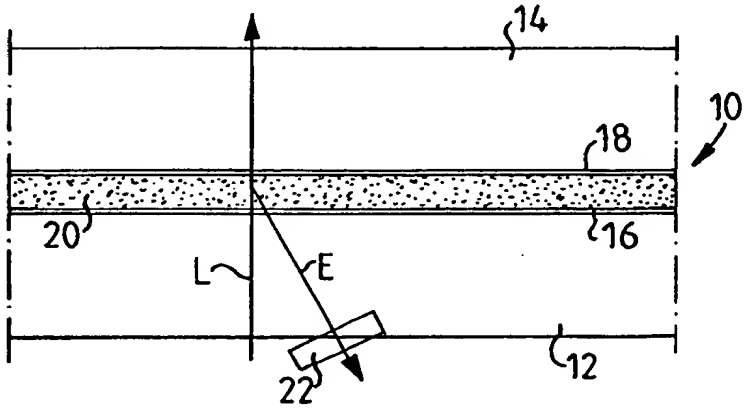
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.
In English translation (filed in Swedish).

(54) Title: PROCESS FOR OPTICAL MEASUREMENT OF THE THICKNESS OF AN ADHESIVE LAYER, AN OPTICAL DATA-STORING DISC, ITS MANUFACTURING AND ALSO AN ADHESIVE AND ITS USE

(57) Abstract

There is suggested according to the invention that when gluing together information-carrying disc substrates into an optical, data-storing disc, there be used an adhesive in which there is mixed an evenly distributed trace amount of a fluorophore. This makes it possible, by measuring the fluorescent light, to determine and check the thickness of the adhesive layer between the substrates.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

PROCESS FOR OPTICAL MEASUREMENT OF THE THICKNESS OF AN ADHESIVE LAYER, AN OPTICAL DATA-STORING DISC, ITS MANUFACTURING AND ALSO AN ADHESIVE AND ITS USE

The present invention relates in general to the manufacture of optical, data-storing discs, in particular to a process for optical control measurement of the thickness of the layer of adhesive between two transparent disc substrates for optical, data-storing discs of so-called DVD type.

When manufacturing DVD discs, two 0.6 mm thick disc substrates of polycarbonate are normally glued together, and at least one of the facing sides of the substrates carries a reflecting information layer containing a large number of short and long depressions with a depth of circa 0.1 μm arranged in a spiral roll around the disc substrate.

In DVD discs of the "SD5" type with a single information layer which is completely reflecting for the intended laser light, the adhesive quality requirements as regards air-bubbles, refractive index and the thickness of the adhesive layer are not critical. However, very high demands as regards the above-mentioned criteria are placed on DVD discs of "SD9" type, which have two information layers facing each other, where one layer consists of a laser semi-reflecting layer of e.g. Al, Au or SiN, while the other information layer is made semi-reflecting. The adhesive must be entirely free of air-bubbles and have a refractive index which is complementary to the refractive index of the substrates in order not to cause refractive errors when sensing laser light focused on the fully reflecting information layer, i.e. when the laser light passes the adhesive layer.

The third criteria, i.e. the adhesive layer thickness between the information layers, is also essential to assuring correct focusing of the laser light beams on the completely reflecting information layer. According to current specifications, the adhesive thickness should be between 40 and 70 μm, i.e. up to 55 μm ±15 μm, and the adhesive

thickness may vary by ±10 μm within the same DVD disc and a maximum of ±4 μm during one rotation, i.e. at a given radius on the same disc.

One method of control-measuring the gap between the information layers, i.e. the thickness of the adhesive layer, is to allow a laser pick-up to focus on the various information layers and then calculate the distance between them. This method provides accuracy in measuring the layers, but the measurement takes a long time to carry out.

Another method is to simply measure the total thickness of the finished DVD disc and, based on assumptions concerning the substrate thicknesses, calculate the thickness of the adhesive layer. This method is much more rapid but the sources of error are, however, significant.

One purpose of the present invention is to suggest a more rapid and reliable method of accurately determining or checking the thickness of the adhesive layer in DVD discs.

According to a first basic aspect of the invention it is suggested that, when gluing together the substrates, an adhesive should be used in which there is admixed an evenly distributed trace amount of a fluorophore, i.e. a fluorescent agent. It is thus possible, with the aid of a beam of light of a predetermined, suitable wave-length, to excite the fluorophore in the beam path through the adhesive layer. By detecting at the same time a fluorescent light emitted by the excitation from this beam path in the adhesive layer and having a longer wave-length, it is possible, on the basis of the strength of the detected emitted fluorescent light, to calculate the thickness of the adhesive layer and to check that this thickness lies within a given tolerance range.

In accordance with the above-mentioned principles, the following categories of claims are encompassed by the present invention:

a) a process for optical control measurement of the thickness of an adhesive layer of an optical, data-storing disc by fluorescent light measurement;

b) a process for manufacturing an optical, data-storing disc with an adhesive layer containing a trace amount of a fluorophore;

c) use of an adhesive containing a trace amount of a fluorophore when gluing together disc substrates for an optical, data-storing disc;

d) an adhesive containing a trace amount of a fluorophore for gluing together disc substrates for an optical, data-storing disc; and

e) an optical, data-storing disc comprising an adhesive layer containing a trace amount of a fluorophore.

These categories are based on a common, unified inventive concept.

Further features of the invention will be described in more detail below with reference to the accompanying drawing and are defined in the subsequent patent claims.

In the attached drawing:

Fig. 1 shows schematically a cross-section of a so-called DVD disc with two information layers, a control measurement of the thickness of a fluorophore containing an adhesive layer between two disc substrates;

Fig. 2 shows a DVD disc which is illuminated by a linear beam; and

Fig. 3 shows a diagram showing the strength of an emitted fluorescent light of a predetermined wave-length as a function of the angular position on the disc.

10 in Fig. 1 designates an optical, data-storing disc of so-called DVD type, and in particular a DVD disc with two information layers of a type which is commonly designated "SD9".

The disc 10 comprises two transparent disc substrates 12 and 14 of polycarbonate, for example, with a normal thickness of circa 0.6 mm and a diameter of circa 120 mm. The disc substrates 12 and 14 each have an individual information layer 16 and 18, respectively, on their facing sides having very compact spiral grooves, containing relatively short and long depressions with a depth of circa 0.1 μm. The information layer 16 on one disc substrate 12 is coated with a layer of Al, Au or SiN, for example, which is semi-reflective for laser light, while the information layer 18 on the other disc substrate 14 is made in a similar manner but completely reflective. The two disc substrates 12,14 are held together by means of a thin layer 20 of adhesive, the index of refraction of which should be complementary to the index of refraction of the substrates (polycarbonate) in order not to give rise to refractive errors when a laser light of a predetermined wave-length is to read the upper information layer 18. The adhesive can, for example, be of a suitable epoxy type or be acrylate-based.

In addition to the requirement of the adhesive being absolutely free of air-bubbles and having a correct index of refraction, it is of the utmost importance that the thickness of the adhesive layer not vary outside a predetermined range of 40 to 70 μm between different DVD discs. The thickness can vary between different discs ±15 μm at a mean thickness of 55 μm. Furthermore, the adhesive thickness may vary by ± 10 μm within a single disc and a maximum of ± 4 μm during a single revolution, i.e. at a specific radius within the same disc. If these tolerances are not maintained, the laser pick-up of the DVD player will have difficulty in correctly focusing on the fully reflecting information layer 18.

In accordance with the present invention there is now suggested a rapid and reliable method of accurately determining and checking that the adhesive thickness lies within a predetermined interval and that the variations in the adhesive layer thickness lie within predetermined tolerance values. Thus, the core of the invention can be considered to reside in admixing and evenly distributing a small trace amount of

a fluorophore, e.g. fluorescein, in an adhesive with a suitable index of refraction for laser light and which are suitable for bonding together information-carrying disc substrates, and that this trace amount of a fluorophore is used as an aid in determining and checking the thickness of the adhesive layer or thickness variations. The fluorophore may be present in an amount of some tenth of a microgram per liter adhesive. The adhesive can, for example, be of suitable epoxy type or be acrylate-based.

In an illustrative example, shown schematically in Fig. 1, of the invention, a beam of light L having a wave-length of circa 488 nm is directed through the disc substrates 12 and 14 and through the adhesive layer 20, and the fluorophore molecules struck by the light beam L in the beam path through the adhesive layer 20 will be excited and emit a spectrum of fluorescent light emitted in various directions.

However, the light beam L can in practice with advantage be a linear beam A formed by a large number, e.g. 200-300, of tightly spaced light sources (not shown) arranged in a line as indicated in Fig. 2, the linear beam A extending substantially axially through the disc 10 in a radial formation so that the entire adhesive layer between the information layers 16,18 can be rapidly illuminated during one rotation of the disc 10. In a similar manner, a row of detectors (not shown) can be placed on the same side of the DVD disc as the light sources but arranged to detect fluorescent light E, emitted in the beam path through the adhesive layer 20, in a direction different from the direction for the incident light (Fig.1), the detectors sensing the strength of the emitted fluorescent light E having a longer wave-length, e.g. circa 530 nm. A blocking filter 22 can be arranged in the beam path for the selected, detected fluorescent light E in order to filter out interfering light reflections which can arise from the exciting light beam L in the adhesive layer 20, when it strikes possible contaminating particles in the adhesive.

Since the thickness of the thin information layers 16,18 of Au and Al (circa 180-220 Å) can vary somewhat from disc to disc, and this affects the value of the detected reflective light from the light path through the information layers 16,18 and the adhesive layer 20, a calibration of the light reflection and the light transmission through the semi-reflecting information layer 16 and the completely reflecting information layer 18 can precede the measuring procedure of the detected reflective light. This can be done, for example, by test illumination at the center portion of the disc of exposed, spaced test surfaces of the respective information layers 16,18, the relevant basic data (constants) being obtainable for the information layers for direct subsequent calculation of the thickness of the adhesive layer.

The strength of the selected emission light E from the illuminated adhesive gap can, in the case described, be related to the thickness of the adhesive layer in a directly proportional manner. When the cross-section of the exciting light beam L can be kept constant, the signal strength of the detected light E will only depend on the thickness of the adhesive layer.

Fig.3 illustrates a curve showing the variation in intensity of the detected fluorescent light E during one rotation of the DVD disc 10 shown in Fig.2. The interval between the intensity levels I_1 and I_2 can in this case be calculated to correspond to a variation of $\pm$ 4 µm in the thickness of the adhesive layer. In the case shown, the variation in thickness of the adhesive layer lies within the specified tolerance range.

Claims

1. Process for optical control measurement of the thickness of an adhesive layer (20) between two disc substrates (12,14), such as transparent disc substrates for optical, data-storing discs of so-called DVD type, **characterized** in that a light beam (L) of a predetermined wave-length is directed through an adhesive layer (20) containing an evenly distributed trace amount of a fluorophore for exciting the fluorophore in the beam path in the adhesive layer, that fluorescent light (E) of longer wave-length emitted by the excitation from the adhesive layer is detected, and that, on the basis of the strength of the detected light (E), the thickness of the adhesive layer (20) is calculated.

2. Process according to Claim 1, **characterized** in that the exciting light beam (L) is in the form of a linear beam (A), formed of a line of a plurality of tightly spaced light sources, arranged to direct a light beam essentially axially through the disc (10) in a radial formation, and that the disc (10) is rotated.

3. Process according to Claim 1 or 2, **characterized** in that the fluorescent light (E) emitted through excitation is detected in a direction deviating from the beam path for the incident, exciting light beam (L).

4. Process for the manufacture of an optical, data-storing disc, in which two disc substrates (12,14), where one substrate (12) has a semi-reflecting information layer (16) and the other substrate (14) a fully reflecting information layer (18), are bonded together with the information layers (16,18) facing each other to form a disc (10) of so-called DVD type with a predetermined thickness of an adhesive layer (20) bonding together the substrates (12,14), **characterized** in that an adhesive is selected which contains a trace amount of a fluorophore.

5. Process according to Claim 4, **characterized** in that the fluorophore is fluorescein.

6. Optical, data-storing disc comprising two disc substrates (12,14) glued together, one substrate (12) having a semi-reflecting information layer (16) and the other substrate (14) having a fully reflecting information layer (18), the information layers (16,18) facing each other with an adhesive layer (20) of a predetermined thickness therebetween, bonding the disc substrates together, **characterized** in that the adhesive layer (20) contains a trace amount of a flurophore.

7. Optical disc according to Claim 6, **characterized** in that the fluorophore is fluorescein.

8. Use of an adhesive layer containing a trace amount of a flurophore bonding together two disc substrates (12,14) into an optical, data-storing disc (10).

9. Adhesive, especially an adhesive transparent to laser light, for bonding together information-carrying disc substrates (12,14) into an optical, data-storing disc (10) of so-called DVD type, **characterized** in that the adhesive contains an evenly distributed trace amount of a fluorophore.

10. Adhesive according to Claim 9, **characterized** in that the fluorophore is fluorescein.

1/1

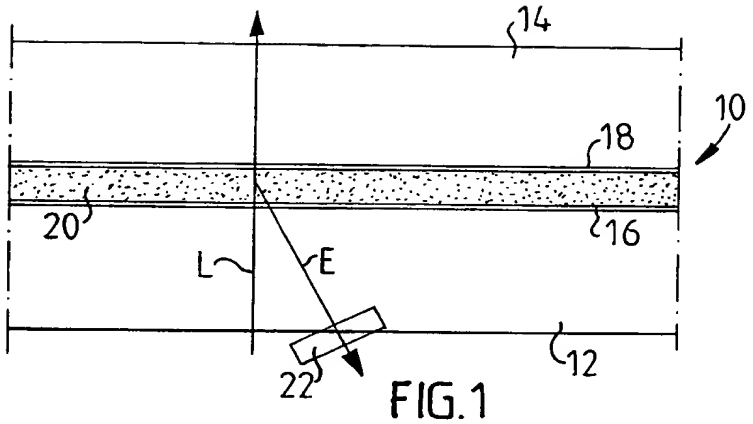


FIG.1

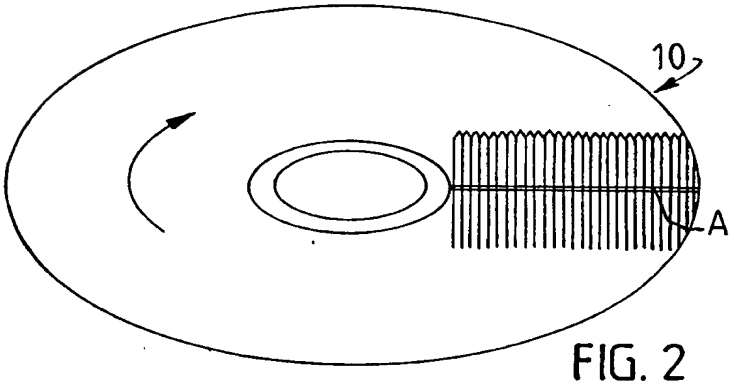


FIG. 2

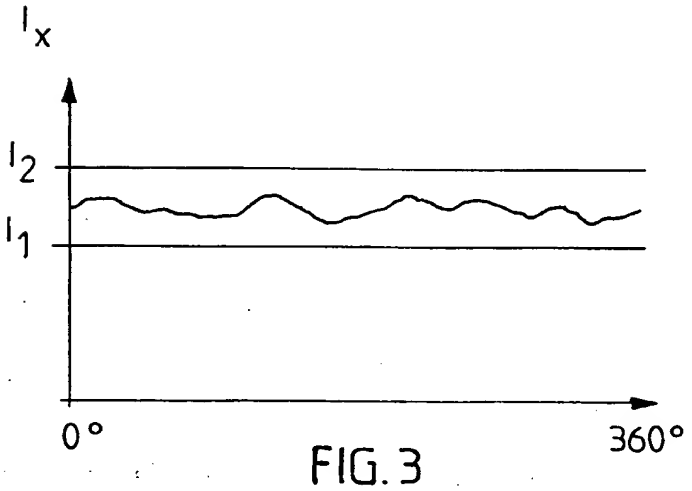


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 97/02043

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G01B 11/06
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 2907620 A1 (FRAUNHOFER-GESELLSCHAFT), 28 August 1980 (28.08.80), see whole document --	1,4,6,8,9
A	GB 2099994 A (ENSO-GUTZEIT OSAKEYHTIÖ), 15 December 1982 (15.12.82), figure 1, abstract --	1,4,6,8,9
A	US 4814198 A (P. BAECKLUND), 21 March 1990 (21.03.90), abstract --	1,4,6,8,9
A	GB 2254917 A (HEIDELBERGER DRUCKMASKISCHINEN AKTIENGESELLSCHAFT), 21 October 1992 (21.10.92), figure 1, abstract --	1,4,6,8,9

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 May 1998	01 -06- 1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Lars Jakobsson Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

29/04/98

International application No.
PCT/SE 97/02043

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 2907620 A1	28/08/80	NONE	
GB 2099994 A	15/12/82	CA 1189638 A	25/06/85
		DE 3219962 A	16/12/82
		FI 62420 B,C	31/08/82
		FR 2506929 A,B	03/12/82
		SE 449137 B,C	06/04/87
		SE 8203315 A	30/11/82
US 4814198 A	21/03/90	AU 588773 B	21/09/89
		AU 8133287 A	26/05/88
		EP 0269590 A	01/06/88
		FI 875153 A	25/05/88
		JP 63148113 A	21/06/88
		SE 455441 B,C	11/07/88
		SE 8605019 A	25/05/88
GB 2254917 A	21/10/92	DE 4106313 A	03/09/92